Explosives Analysis with Portable GC-MS for Battlefield Forensics

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Introduction

The GuardIon portable GC-MS is a relatively new and cutting-edge instrument which has as a more streamline, user-friendly interface, is extremely rugged, and can be transported to any type of scene. The use of the portable GC-MS within the area of battlefield forensics has enabled the rapid and conclusive detection and identification of explosives residues at the site of a possible explosion. This instrument is currently being used by several branches of the military, and the aim of this project is to broaden the user-base by creating an improved method for explosives identification.

Currently, explosives are tested at an inlet temperature of 270 ◦C, which is the instrument's standard method, as it has been shown to work with a large range of compounds. However, this temperature is too high for many explosives, as they are thermally labile. The goal of this project was to evaluate a new method with a lower temperature thus preventing degradation of the explosive residue during testing. In this research, 12 explosives were tested at varying inlet temperatures and column conditions to determine new method parameters that could be used for explosive identification. Each of the 12 explosives were deposited onto a SPME fiber, allowed to dry, and then injected into the column at varying conditions. A sample size of 200 ng was used in all trials. Each of the tested methods varied by inlet temperature (decreasing in increments of 20 ◦C from 270 ◦C to 210 ◦C). The run time was 3 minutes. The data was then analyzed to determine the success of the method, based on the detection of the target explosive.

Materials and Methods

Figure 1. GUARDION portable GC-MS

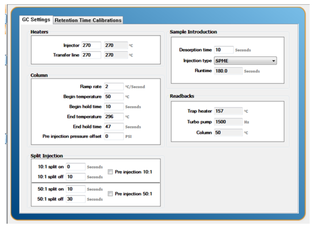

Figure 2. Original method

Results and Discussion

In order to determine whether or not the new method could be implemented, each sample run had to be analyzed to ensure the explosives being injected were detected. For a few of the samples, including TATP, PETN, DMNB, and EGDN, no manual analysis was needed; they were clearly detected by the library match throughout all of the trials. However, for others further analysis was needed.

Explosive	Optimal Conditions for Detection	Comments
TATP	All	---
PETN	All	---
DMNB	All	---
EGDN	All	---
HMTD	All	Required manual ID because not in the MS library
ETN	All	Required manual ID because not in the MS library
Sulfur	All	Required manual ID because not in the MS library
DNT	All	Thermal degradation products initially masked DNT
TNB	250◦C	Thermal degradation at higher temperatures
TNT	250◦C	Thermal degradation at higher temperatures
HMX	250◦C	Thermal degradation at higher temperatures
RDX	Not detected	Requires significantly lower temperature to prevent thermal degradation

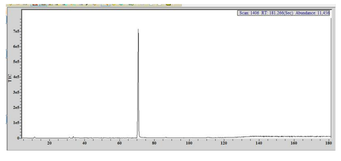

Figure 3. Chromatogram of DMNB at 210 C

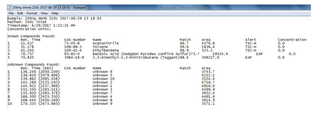

Figure 4. Hits list for DMNB at 210 C

Conclusions

Portable GC-MS is a viable method for explosives detection. In 11 out of 12 explosives tested, either the explosive or it's thermal degradation product were detected and identified. Of the methods tested on, it was concluded that the lower temperatures, specifically 250 ◦C yielded better, less degraded results.

Future Work

In order to refine the methods being tested, further work will be pursued. In this experiment, varying the inlet temperature was the main focus: in each of the methods the inlet temperature was changed in order to determine how temperature played a role in the degradation and identification of each explosive. Since this has now been determined, other parameters can be tested to determine if there is a method which can further decrease the degradation and increase the detection and identification of each of the explosives. Additional testing will also include limit of detection determinations as well as the testing of real world samples collected from explosions.

The results of this research have the potential to make an immediate impact via the implementation of a new method for explosives identification by the military.

References

1. Leary, P., Dobson, G., Reffner, J. (2016). Development and Applications of Portable Gas Chromatography-Mass Spectrometry for Emergency Responders, the Military, and Law-Enforcement Organizations. *Applied Spectroscopy.*
2. Lammert, S. et all. *Miniature Toroidal Radio Frequency Ion Trap Mass Analyzer.*

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